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Preliminary study on the evaluation of musculoskeletal risks through infrared thermography fordrummers

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Abstract

Playing the drums requires effort, speed and highly repetitive movements. Drummers are constantly exposed to maintain uncomfortable and unhealthy postures by long periods of time, which increases the risk of musculoskeletal injuries. A professional drummer performsfromthreeto 6 hours daily to achieve high performance levels.Because of that, they constantly suffer discomfort and lower back pain. The purpose of this work is to develop a protocol to monitor skin temperature in a professional drummer, the study was performed by monitoring the temperature on skin surface at the lower back, using infrared thermography as noninvasive method for collecting the data of the surface temperature in the human body. It is intended to use these data to assess musculoskeletal risks of injuries. A professional drummer was subjected to an acclimation period of 5 minutes in a musical studio. After the acclimation period, the first thermal image is captured. Thermal images of the lower back of the drummer were captured every 15 minutes of practice for three periods. After the analysis of thermal images it can be observed the variations of temperature in the lower back of the drummer. There are few studies in the literature regarding the use of infrared thermography to monitor the temperature of the drummers. The data obtained in this study may be useful for the design and development of new products and workstations for drummers to reduce the risk of musculoskeletal injury.

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*Keywords:*Infraredthermography; Musculoskeletaldiseases; Lower back; Highlyrepetitive; Design

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1. Introduction

Learning to play amusicalinstrumentinvolves a large numberof practicing hours, assumingposturesnecessaryfor the interpretationof the instrument.Playing a musical instrumentis one ofthe most complex tasksthat the human bodycan perform.Muscles,joints and nerves areoftenoperating aboveits normal capacity.Musicians areat high riskof developingmusculoskeletalproblems, including pain and injuryby highlyrepetitivemovements,their skills are threatenedwhen they are nolonger able toplayhis instrumentdue to pain.Theemployment status ofmusicianshas a potentialimpact onrisk factors, often working conditionsprovidea significantly greaterrisk of injury,many orchestra chairsare not totally suitablefor musicians,includingalso poor lighting conditionsandnoise levels[1,2,3].

The combination ofawkward posturingand repetitive movementshave proved particularlystressand may contributeto muscle damage. Often,musical instrumentshave becomean extensionof professional musicians. Musical instrumentswere designedwithout incorporatingergonomic aspects, despite someefforts toimprove its design,playing a musicalinstrument canbe physicallychallenging.Somemusical instrumentshave specific characteristicsthat might predisposethe musicianto injury[4].

Musculoskeletal injuriesarethe most common disorderin musicians.Afterthe dancers,musicians arethe second populationmost commonlytreatedby physiotherapists[5]. Musculoskeletalinjuries affecta variety oftissues includingbones,joints, cartilage, ligaments, tendons, muscles and other softtissues [6].

Somestudies report thatthe most common diagnosesin musiciansis theoverusesyndrome, resulting fromrepetitive movementsand aprolonged exertionoften inuncomfortable positions[7]. Themusculoskeletal painassociated withplaying musical instrumentshas been reportedfor many decades.The physical symptoms ofthese problemsarea tingling, muscle stiffness and pain due todamage ofthe muscles, nerves and tendons[8].

Likeathletes,musiciansdevoteconsiderable timetothe development and improvementof certainphysical abilities.Some specific muscle groups arerepetitivelyusedby musicians for long periods oftime, whichincreases thelong-termrisk of injury.Some surveyshave indicatedthat between 50and80% of professional musicians havesymptomsofmusculoskeletal pain[9].

Changing metabolism andmuscle usageare major sourcesof body heat, heat is transferredfrom the centerto the peripheryof the bodythrough thebloodstream; the result,is the lossof heat,mainly at the skin. Historically,temperature hasproven to bean indicatorof health;temperatureis usedfor clinical diagnosis, the human being is capableof maintaining a constanttemperature, whichmay be different fromthe environment [10].

Drummerspracticeandworkfor long periods oftime, constantlyperformingintense physical activitybecause theyare exposed tohigh demandsdue tovery slenderand repetitivemovements performedat high speed andover long periodsof time.The intensephysical activityincreases body temperatureand throughthe human bodyskin,that heat isexchangedthrough the environment. Infrared thermographycan detectthese temperature changeson the surface ofthe skindrummers. Thermographycancollectthermal datathat identifyrisk factorsthat may causemusculoskeletal disorders[11].

Infrared thermographycameras(IR) sense theinfrared radiation emitted byan object andthis corresponds toatemperature value. Aninfrared thermographysystemcomprisesa camera, which has an IR detector, theIR radiation isabsorbedandit becomes anelectrical signal.Emissivityof cleanhuman skinis approximately0.98. This value is aresult of manystudies conducted over aperiod of30 years.Thetemperature valueis correctonly when the valueofthe emissivityis well defined.This isbecause themeasured temperatureis a functionof emissivity[12, 13].

The movement andmuscle tensionincreases blood flow, infrared thermographycan detectthe energy emitted byvessels and arteries, the more bloodflow, the greater the energy emitted. Thermal imagingcameras canmeasure thisincrement in energy and translate it to temperature values.Infrared thermography isa non-invasive, comfortable procedure for the patientand easy tocarry out, its results might help to locate pain, and to gather useful information for studies ofmusculoskeletaldisorders [14,15].

2. Materials and methods

2.1. Selection of subjects

A professionaldrummerwith over 20years of professional experiencewas invited toparticipate in the study. In orderto comparethe results ofthe thermal images, other five subjects (students of the drummer)werealso invited to participate. Prior to the study,an interviewwith the participantswas carried out, asking them ifthey had anypriormusculoskeletallesions, none of them reportedprevious injuries. All participantsreported experiencingfrequent lower back pain.

2.2. Materials

The experimentwascarried outina practicestudyset of the experienced drummer.A thermal cameraFLIRE40was usedwithan original calibration certificate,it is capable of reading temperature rangesfrom -20° to650°C, it has athermalSensitivityof <0.07°C@30°C., and a 160x 120IRResolution. TheFrame Rate is60Hz, and thespectral range goes from7.5 to13µm. Acommondrummersstoolwas used with adjustable height, aReymatbranddrum set, a pair of drumsticks, an equalizer and a headsetswatch.Thetemperature monitoringwas performed usingthe methodof infrared thermographyit is a noninvasivetool forrisk assessment ofmusculoskeletaldiseases [16]. Experimental developmentis divided intwo parts: Firsta), an uncoatedwoodseatwithoutheight adjustment was used. Thenb), a common drummersstoolcoatedand with adjustable height was used.Figure 1, shows the practicestudyset of the experienced drummerand the two types of seat used in the experiment.

2.3. Protocol

Participants reported their consent for the study, as well as their availability and interest to participate in future studies. Exclusion criteria were that all participants were free of any acute or chronic disease, no colds or any disease that affects body temperature. The structure of the study session was at the discretion of each participating drummer. Before the experiment, the participants were instructed to do not take any drinks containing caffeine, they were also asked not to smoke [17]. Participants were divided into two groups, 3 of them for monitoring the temperature in the lower back using the wooden seat and 4 of them using the stool, in both groups have participated the drummer with over 20 years of experience. The first thermal imaging was conducted with each participant at rest, then participants were instructed to play drums for a period of 45 minutes without rest periods, each 15 minutes the thermal image was captured.

a b c

Fig.1.(a)Studyof practice,(b) Wooden seat. (c) Common drummersstoolcoatedandheight adjustable.

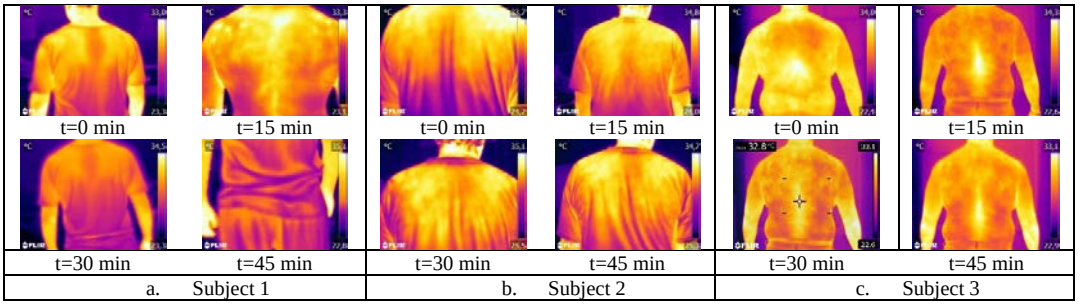


Fig.2.Thermal imaging(a)professionaldrummer, (b) and(c) Drummer student.

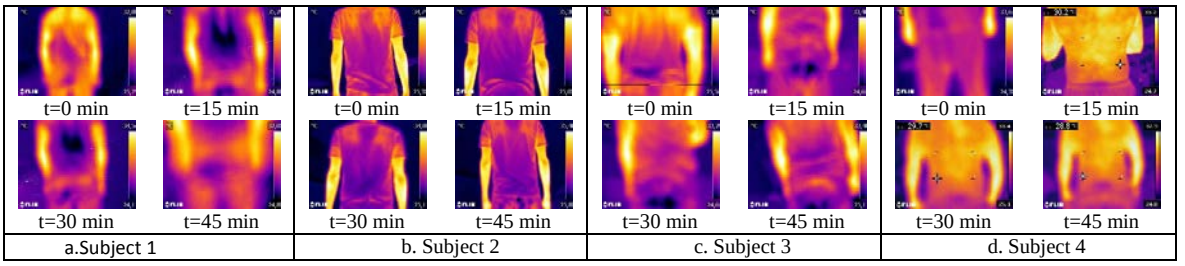
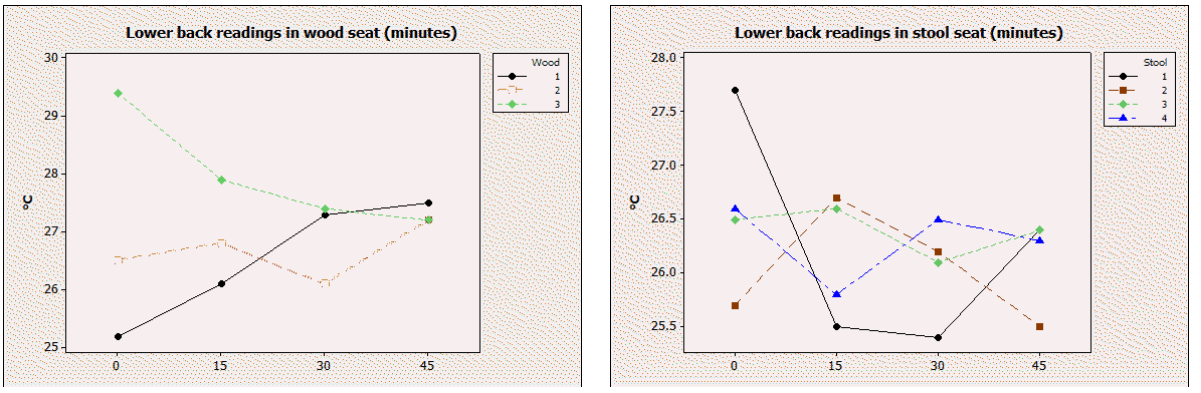


Fig.3.(a),(b) and, (c) Students, (d) ProfessionalDrummer.

3. Results

After the thermal images´ evaluation, it can be observedinFigure 2 thevariation of temperatureobserved inthe lower backusinga wooden seat. It is worth mentioning that at the beginning of the test, participants tried to adjust its height as if it was a regular drummers stool.

Figure 3, showsthe lower back imagesof the participantswhen they used acommondrummersstoolwith adjustable height. Subject 2reported that healso plays thepiano, buthis main instrumentis drums. In this experimentparticipated againthe most experienced drummer, which is subject 4.Subject 3reportedstrenuous exercisebefore the study. He exercises intenselybetween5 and 6days a week. The fourparticipants agreedto workexposed to highnoise levels andlow lightbesidescomplaining of painin different regionsof the back.All participants reportedthat they usually adjust the stool´s height. Participants 2, 3and 4 also reported to usually adjust cymbals´heightand the distance ofthe snare drum.



a b

Fig. 4.Graphictemperaturebehavior(a)Wooden seat;(b)commonstoolfor drummers.

Figure 4, showsthe behavior of thetemperature atthe lower back. Whenusingawooden seat, the maximum temperature registered at the beginning of the study was 29°C onsubject 2,andthe minimum temperature was26.1°Cafter 15 minutes of playing, itwas registered on the participant2. This value is the same for him atminute30.It can be seenthat45minutes later,subjects2 and 3showed avalue of27.2°Cwhile the subject1 registereda value close to27.5°C. Usingthe common drummersstool it was observed thatsubject 1 registereda maximum temperature of27.7°Cat the beginning of this part of the study, being this subject the same one who registered the lowest temperature of25.4°Cafter 30 minutes.

4. Discussion

Participantdrummersin this researchreported thatdue to hisstrenuousworkandpracticesessions, theyremain at static awkward posturesand they undergo constantmuscle aches.

The obtained results show lower back temperature variationsusing two differentcomponentsofthe workstation. It is noticeable that the most experienced participant (which was subject 1 when the wooden seat was used, and subject 4 when the drummer stool was used) was the subject who reported the most intense discomfort. It should be taken into account that the workstation (drums) used in this experiment belong to him. Therefore, his discomfort could be due to the deficient ergonomic conditions of his workstation.

When participants used acommon drummersstool, it was observed that subject 3 (who works out regularly) recordeda lowervariation oftemperature in the involved zone incomparisonwith other participants. These results might showthe benefit ofexercising the muscles, especially the musclesof the back, toprevent and counteractbad posturingcausedby highlyrepetitive movements. Exercise can relieve symptoms[18].

Another particularcasewas observedin the areaof the lower backfor this study case, subject 2showedthe range oflowesttemperature values at the lower back areacompared tothe other participants.This could be due tohow hestructured thesession, starting with a warm up andthengraduallyincreasing theintensity ofinterpretation.

Figure 5, showsthe temperatureintervalsfor the wooden seatand commondrummers stool is presented. Itis observed thatthe temperatures measuredfor the case ofwooden seatare higher comparedwith the temperatures measured when using the stool. The lower back temperatureregistered an average valueof32.10°Cusing thewooden seat, while when thestoolwas used it registered a value of29.83°C, these results couldbe due tothe need of drummersto customizetheir workstation.Thecommonstoolallows them toadjust the height, however, they presentdiscomfort and pain inthe involved areas,this means thattheir requirementsare not metwith any of theseats usedin the experiment.

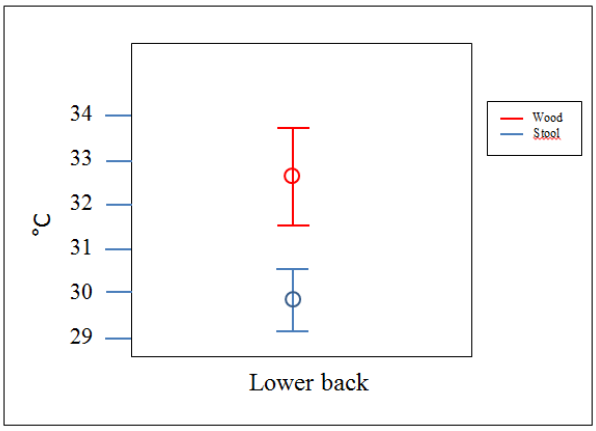


Fig. 5.Temperature interval chart.

5. Conclusions

Thermographic images show variations in lower back temperature valueswhen participants reported pain, demonstrating the usefulness of infrared thermography as a diagnostic tool for musculoskeletal injuries. Thermal images can be used for research of diseases when skin temperature shows tissues inflammation

During the experiments, it was observed that drummers often keep awkward posturing over long periods of time. This is a risk factor for musculoskeletal injuries. Some relevant specific cases were observed, which show the benefits of regular exercise and proper warm up before playing with full intensity to prevent discomfort.

Very often drummers adapt your body to the instrument, ergonomic changes, physically fit, exercise the muscles, correct bad posture, structure practice sessions and improve the lighting conditions are actions that can reduce the risk of musculoskeletal injuries drummers.

Experiments revealed that drummers adjust the height of some elements of the drum set, such as cymbals and snare, this is done according to its body dimensions, the number of components does not allowto locatethemin an area of optimal work. With appropriate modifications, it is possible to build on this research toergonomicallydiagnosethe workstationsstate for drummers and to assess their exposure to risk factors for their health.

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